

Table of Contents

ABSTRACT	
TABLE OF CONTENTS	i
LIST OF FIGURES	ix
LIST OF EXAMPLES	xi
LIST OF TABLES	xiii
LIST OF EQUATIONS	xv

Chapter 1: Introduction

1.0	CHAPTER OVERVIEW	1-1
1.1	THE ENERGY STANDARDS	1-1
1.1.1	Legal Requirements	1-2
1.1.2	Organization of Standards	1-2
1.1.3	California Climate Zones	1-2
1.2	BASIC APPROACHES TO COMPLIANCE	1-5
1.3	HISTORY OF THE STANDARDS	1-7
1.4	CHANGES IN THE 1995 STANDARDS	1-8
1.4.1	Structural	1-8
1.4.2	Technical	1-8
1.5	ORGANIZATION OF THIS MANUAL	1-10

Chapter 2: Scope and Application

2.0	CHAPTER OVERVIEW	2-1
2.1	INTRODUCTION	2-1
2.1.1	When Standards Apply	2-1
2.1.2	Basic Scope and Application Concepts	2-3
	A: Conditioned Space Definitions	2-3
	B: Occupancies	2-6

2.2	APPLICATION SCENARIOS	2-7
2.2.1	Unconditioned Space	2-7
2.2.2	Newly Conditioned Space	2-7
2.2.3	New Construction in Existing Buildings	2-9
2.2.4	Alterations to Occupied Spaces	2-9
2.2.5	Additions	2-11
2.2.6	New Buildings	2-12
	A: Speculative, Known Occupancy	2-12
	B: Speculative, Unknown Occupancy	2-13
	C: Mixed Use	2-13
	D: Semi-Conditioned	2-14
2.2.7	Change of Occupancy	2-14
2.2.8	Repair	2-14

Chapter 3: Building Envelope

3.0	CHAPTER OVERVIEW	3-1
3.1	INTRODUCTION	3-2
3.1.1	Envelope Compliance Approaches	3-2
	A: Prescriptive Approach	3-2
	B: Performance Approach	3-2
3.1.2	Basic Envelope Concepts	3-3
	A: Definitions	3-3
	B: Insulation R-value	3-7
	C: Overall Assembly U-value	3-7
	D: Wood Frame U-values	3-7
	E: Metal Frame U-values	3-9
	F: Masonry U-values	3-10
	G: Heat Capacity	3-11
	H: Fenestration U-values	3-12
	I: Solar Heat Gain Coefficient	3-13
	J: Relative Solar Heat Gain	3-13
3.2	ENVELOPE DESIGN PROCEDURES	3-15
3.2.1	Mandatory Measures	3-15
	A: Doors, Windows and Skylights	3-15
	B: Joints and Openings	3-16
	C: Insulation Materials	3-16
	D: Demising Walls	3-16

3.2.2	Prescriptive Component Approach	3-17
	A: Exterior Roofs and Ceilings	3-17
	B: Exterior Walls	3-18
	C: Demising Walls	3-18
	D: Exterior Floors and Soffits	3-19
	E: Windows	3-19
	F: Skylights	3-21
	G: Exterior Doors	3-22
3.2.3	Prescriptive Overall Approach	3-22
	A: Overall Heat Loss	3-24
	B: Overall Heat Gain	3-26
3.2.4	Performance Approach	3-29
	A: Modeling Envelope Components	3-29
3.2.5	Alterations	3-30
3.3	ENVELOPE PLAN CHECK DOCUMENTS	3-30
3.3.1	ENV-1: Certificate of Compliance	3-31
3.3.2	ENV-2: Envelope Component Method	3-39
3.3.3	ENV-2: Overall Envelope Method	3-43
3.3.4	ENV-3: Metal Framed Assembly	3-53
3.3.5	ENV-3: Masonry Wall Assembly	3-56
3.3.6	ENV-3: Wood Frame Assembly	3-59
3.4	ENVELOPE INSPECTION	3-62

Chapter 4: Mechanical Systems

4.0	CHAPTER OVERVIEW	4-1
4.1	INTRODUCTION	4-2
	4.1.1. Mechanical Compliance Approaches	4-2
	4.1.2. Basic Mechanical Concepts	4-3
	A. Definitions of Efficiency	4-3
	B. Definitions of Spaces and Systems	4-4
	C. Types of Air	4-5
	D. Air Deliver System	4-6
	E. Attics and Return Plenums	4-6
	F. Zone Reheat, Recool and Air Mixing	4-6
	G. Economizers	4-7

	H. Unusual Sources of Contaminants	4-8
	I. Demand Control Ventilation	4-8
	J. Intermittently Occupied Spaces	4-8
4.2	MECHANICAL DESIGN PROCEDURES	4-9
	4.2.1 Mandatory Measures	4-9
	A. Equipment Certification	4-9
	B. Control Equipment Certification	4-10
	C. Pilot Lights	4-10
	D. Outdoor Ventilation	4-10
	E. Natural Ventilation	4-11
	F. Mechanical Ventilation	4-12
	G. Ventilation System Operation and Controls	4-16
	H. Required Controls for Space Conditioning Systems	4-21
	I. Requirements for Pipe Insulation	4-26
	J. Requirements for Ducts and Plenums	4-28
	K. Service Water Systems	4-29
	L. Pool/Spa Heating Systems	4-31
	4.2.2 Prescriptive Approach	4-31
	A. Sizing/Equipment Selection	4-31
	B. Load Calculations	4-32
	C. Fan Power Consumption	4-34
	D. Space Conditioning Zone Controls	4-37
	E. VAV Zone Controls	4-38
	F. Economizers	4-38
	G. Supply-Air Temperature Reset Control	4-40
	H. Electric Resistance Heating	4-41
	I. Service Water Heating	4-41
	4.2.3 Performance Approach	4-41
	A. Compliance with a Computer Method	4-42
	B. Modeling Mechanical System Components	4-42
	4.2.4 Alterations/Additions	4-42
	4.2.5 Application to Major Systems Types	4-42
4.3	MECHANICAL PLAN CHECK DOCUMENTS	4-57
	4.3.1 MECH-1: Certificate of Compliance	4-57
	4.3.2 MECH-2: Mechanical Equipment Summary	4-69
	4.3.3 MECH-3: Mechanical Ventilation	4-75
	4.3.4 MECH-4: Mechanical Sizing and Fan Power	4-78
4.4	MECHANICAL INSPECTION	4-82

Chapter 5: Lighting Systems

5.0	CHAPTER OVERVIEW	5-1
5.1	INTRODUCTION	5-2
5.1.1	Lighting Compliance Approaches	5-2
5.1.2	Basic Lighting Concepts and Definitions	5-3
A.	Lighting Trade-Offs	5-3
B.	Definitions	5-4
C.	Occupancy Type	5-7
D.	Lighting Controls	5-9
5.2	LIGHTING DESIGN PROCEDURES	5-10
5.2.1	Mandatory Measures	5-10
A.	Area Controls	5-10
B.	Bi-Level Switching	5-11
C.	Daylit Areas	5-11
D.	Shut-Off Controls	5-16
E.	Display Lighting	5-18
F.	Exterior Lights	5-18
G.	Tandem Wiring	5-18
H.	Certified Automatic Lighting Control Devices	5-18
I.	Certified Ballasts and Luminaires	5-20
J.	High Rise Residential	
	Living Quarters & Hotel/Motel Guest Rooms	5-21
5.2.2	Prescriptive Approach	5-24
A.	Complete Building Method	5-24
B.	Area Category Method	5-25
C.	Tailored Method	5-28
D.	Simplification for Tenant Spaces	5-36
E.	Summary	5-36
5.2.3	Performance Approach	5-40
5.2.4	Actual Lighting Power	5-40
A.	Exempt Lighting	5-40
B.	Actual Lighting Power Calculations	5-41
C.	Automatic Lighting Control Credits	5-43
5.2.5	Alterations	5-43
5.3	LIGHTING PLAN CHECK DOCUMENTS	5-46
5.3.1	LTG-1: Certificate of Compliance	5-46
A.	LTG-1 Part 1 of 2	5-46
B.	LTG-1 Part 2 of 2	5-51
C.	Sample Form: LTG-1	5-52

5.3.2	LTG-2: Lighting Compliance Summary	5-54
	A. Actual Lighting Power	5-54
	B. Allowed Lighting Power	5-54
	C. Sample Form: LTG-2	5-56
5.3.3	LTG-3: Lighting Controls Credit Worksheet	5-57
	A. Sample Forms: LTG-3	5-58
5.3.4	LTG-4: Tailored LPD Summary and Worksheet	5-59
	A. LTG-4: Part 1 of 3	5-59
	B. LTG-4: Part 2 of 3	5-60
	C. LTG-4: Part 3 of 3	5-61
	D. Sample Form: LTG-4	5-64
5.3.5	LTG-5: Room Cavity Ratio Worksheet (≥ 3.5)	5-67
	A. Rectangular Spaces	5-67
	B. Nonrectangular Spaces	5-67
	C. Sample Form: LTG-5	5-68
5.4	LIGHTING INSPECTION	5-69

Chapter 6: Special Topics

6.0	CHAPTER OVERVIEW	6.1
6.1	PERFORMANCE APPROACH	6-2
6.1.1	Summary	6-2
6.1.2	Performance Concepts	6-2
	A. Approval of Computer programs	6-2
	B. The Energy Budget	6-3
	C. Compliance With a Computer Method	6-4
	D. Compliance Procedure	6-5
	E. Application Scenarios	6-5
	F. Professional Judgment	6-8
6.1.3	Analysis Procedures	6-9
	A. Energy Budget	6-9
	B. Source Energy Use	6-10
6.1.4	Performance Plan Check Documents	6-11
	A. PERF-1: Performance Certificate of Compliance	6-13
	B. ENV-1: Envelope Compliance Summary	6-13
	C. ENV-3: Construction Assemblies	6-14
	D. EXISTING-ENV: Performance Method	6-14
	E. MECH-1: Mechanical Compliance Summary	6-14
	F. MECH-2: Mechanical Equipment Summary	6-14

	G. MECH-3: Mechanical Compliance Summary/ Mechanical Ventilation	6-14
	H. LTG-1: Lighting Compliance Summary	6-14
	6.1.5 Performance Inspection	6-14
6.2	HOTELS AND MOTELS	6-15
	6.2.1 Introduction	6-15
	6.2.2 Hotel/Motel Compliance Approaches	6-15
	6.2.3 Basic Hotel/Motel Concepts	6-15
	6.2.4 Hotel/Motel Compliance	6-15
	A. Mandatory Measures	6-15
	B. Prescriptive Compliance	6-16
	C. Performance Compliance	6-17
	6.2.5 Hotel/Motel Plan Check Documents	6-17
	6.2.6 Hotel/Motel Inspection	6-17
6.3	HIGH-RISE RESIDENTIAL	6-17
	6.3.1 Introduction	6-17
	6.3.2 High-rise Residential Compliance Approaches	6-17
	6.3.3 Basic High-rise Residential Concepts	6-18
	6.3.4 High-rise Res. Compliance	6-18
	A. Mandatory Measures	6-18
	B. Prescriptive Compliance	6-18
	C. Performance. Compliance	6-19
	6.3.5 High-rise Res. Plan Check Documents	6-19
	6.3.6 High-rise Res. Inspection	6-19
6.4	SAMPLE FORMS	6-19

APPENDICES

Appendix A:	Compliance Forms
Appendix B:	Materials Reference
Appendix C:	California Design Location Data
Appendix D:	Indoor Air Quality
Appendix E:	Certified Computer Programs
Appendix F:	Publications Directory
Appendix G:	Glossary
Appendix H:	Residential Water Heating and Lighting
Appendix I:	Plan Check Guides and Inspection Checklists

LIST OF FIGURES

Figure 1-1	Organization of the Nonresidential Standards	1-3
Figure 1-2	California Climate Zones	1-4
Figure 1-3	Nonresidential Standards Flowchart	1-5
Figure 1-4	Organization of Chapters 3, 4 and 5	1-10
Figure 2-1	Type of Conditioned Space and Scope of Compliance	2-8
Figure 3-1	Requirements for Floor/Soffit Surfaces	3-4
Figure 3-2	Requirements for Roof/Ceiling Surfaces	3-5
Figure 3-3	Surface Orientations	3-5
Figure 3-4	Skylight Area	3-6
Figure 3-5	Slope of a Wall or Window (Roof or Skylight slope is less than 60°)	3-6
Figure 3-6	Overhand Dimensions	3-13
Figure 3-7	Graph of Overhang Factors	3-14
Figure 3-8	Roof/Ceiling Flowchart	3-18
Figure 3-9	Wall Flowchart	3-18
Figure 3-10	Floor/Soffit Flowchart	3-20
Figure 3-11	Window Flowchart	3-21
Figure 3-12	Skylight Flowchart	3-22
Figure 4-1	Typical Building Energy Use (Energy Efficiency Report, October 1990, California Energy Commission Publication No. 400-90-003)	4-2
Figure 4-2	Integrated Air Economizer	4-7
Figure 4-3	Nonintegrated Air Economizer	4-7
Figure 4-4	Water Economizer	4-8
Figure 4-5	Pre-Occupancy Purge Flowchart	4-18
Figure 4-6	Proportional Control Zone Thermostat	4-21
Figure 4-7	Shut-Off and Setback Controls Flowchart	4-24
Figure 4-8	Service Water Heating Flowchart	4-30
Figure 4-9	Fan Power Consumption Flowchart	4-34
Figure 4-10	VAV Fan Performance Curve	4-36
Figure 4-11	Economizer Flowchart	4-39
Figure 4-12	Supply Air Reset Controls Flowchart	4-40
Figure 5-1	Lighting Energy Use (Lighting accounts for 29% of all commercial building electricity use in California)	5-2
Figure 5-2	Lighting Compliance Flowchart	5-3
Figure 5-3	Bi-Level Switching	5-12

Figure 5-4	Combined Bi-Level and Daylit Area Switching	5-13
Figure 5-5	Window Daylit Area	5-14
Figure 5-6	Skylight Daylit Area	5-15
Figure 5-7	Well Index (Efficiency of Well) Graph	5-15
Figure 5-8	Timed Manual Override	5-17
Figure 5-9	Occupant-sensing Device Shut-off	5-17
Figure 5-10	Tandem Wiring	5-19
Figure 5-11	Residential and Hotel/Motel Guestroom Kitchen Lighting Examples	5-22
Figure 5-12	Residential and Hotel/Motel Guestroom Bathroom Lighting Examples	5-23
Figure 5-13	Complete Building Method Flowchart	5-25
Figure 5-14	Area Category Method Flowchart	5-26
Figure 5-15	Calculating Lighting Area	5-26
Figure 5-16	Chandelier Dimensions	5-28
Figure 5-17	Tailored Method Flowchart	5-29
Figure 5-18	Throw Distances and Mounting Heights	5-33
Figure 5-19	Calculating the Task Area	5-34
Figure 5-20	Gross Sales Wall Area	5-35
Figure 5-21	RCR for Stack Lighting (see Example 5-14)	5-36
Figure 5-22	Lighting Power Density Calculation Flowchart	5-37
Figure 6-1	Annual Sources Energy Use Summary	6-4

LIST OF EXAMPLES

Example 2-1	Research Greenhouse	2-2
Example 2-2	Direct Heating	2-4
Example 2-3	Direct Heating	2-4
Example 2-4	Direct Cooling	2-4
Example 2-6	High-Rise Residential	2-6
Example 2-7	New Window	2-10
Example 2-8	New Lighting Fixture	2-10
Example 2-9	New Interior Partitions	2-11
Example 2-10	Altered Duct Work	2-11
Example 2-11	Chiller Replacement	2-11
Example 2-12	Adding a Mezzanine	2-11
Example 2-13	Energy Inefficient Addition	2-12
Example 2-14	Minor Occupancy	2-13
Example 3-1	RSHG Calculation	3-15
Example 3-2	Area Calculation	3-24
Example 3-3	Glazing Area Adjustments	3-25
Example 3-4	RSHG Determination	3-27
Example 3-5	Determining Weighting Factors	3-28
Example 3-6	Sample Notes Block – Envelope Mandatory Measures	3-34
Example 4-1	Efficiency Compliance	4-10
Example 4-2	Efficiency Compliance	4-10
Example 4-3	Natural Ventilation	4-11
Example 4-4	Ventilation for a Two-room Building	4-15
Example 4-5	Minimum VAV CFM	4-17
Example 4-6	Purge Period	4-18
Example 4-7	Purge with Natural Ventilation	4-18
Example 4-8	Purge with Occupancy Timer	4-18
Example 4-9	Maintenance of Ventilation System	4-20
Example 4-10	Direct Digital Control of Space Temperature	4-21
Example 4-11	Perimeter Systems Thermostats	4-22
Example 4-12	Office Occupancy Sensor	4-23
Example 4-13	Automatic Time Switches with Multiple Systems	4-23
Example 4-14	Thermostat with Sensors	4-23
Example 4-15	Time Control for Fan Coils	4-24
Example 4-16	Isolation Zones	4-25
Example 4-17	Isolation Zone Purge	4-25
Example 4-18	Pipe Insulation Thickness	4-27
Example 4-19	Duct Sealing	4-29

Example 4-20	Equipment Sizing	4-32
Example 4-21	25 HP Limit	4-35
Example 4-22	Filtration	4-35
Example 4-23	VAV Bypass System	4-36
Example 4-24	Calculation of Fan Power	4-37
Example 4-25	Minimum VAV CFM	4-38
Example 4-26	Heat Pump Sizing	4-41
Example 4-27	Series Fan-Powered Box	4-45
Example 4-28	Parallel Fan-Powered Box	4-45
Example 4-29	Dual-Fan Dual-Duct Fan Power	4-51
Example 4-30	Sample Notes – Mechanical Mandatory Measures	4-61
Example 5-1	Lighting Trade-Offs: General Lighting	5-3
Example 5-2	Lighting Trade-Offs: Display Lighting (Parts 1 & 2)	5-4
Example 5-3	Shut-off Control Override	5-11
Example 5-4	Manual Switches and Automatic Controls	5-11
Example 5-5	Effective Aperture Matrix	5-14
Example 5-6	Skylight/Daylit Area	5-14
Example 5-7	Skylight Effective Aperture	5-15
Example 5-8	Complete Building Method	5-25
Example 5-9	Area Category Method	5-27
Example 5-10	Chandelier Wattage Allowance	5-28
Example 5-11	Office Task Duration	5-30
Example 5-12	RCR Calculation	5-31
Example 5-13	Private Office	5-33
Example 5-14	Stack Lighting RCR	5-35
Example 5-15	Simplified Lighting Flowchart, New Building	5-38
Example 5-16	Simplified Lighting Flowchart, Alteration	5-38
Example 5-17	Simplified Lighting Flowchart, Retail/Grocery Combination	5-39
Example 5-18	Track Lighting Power	5-42
Example 5-19	Medium Base Fixture Lighting Power	5-42
Example 5-20	Sample Notes: Lighting Mandatory Measures	5-49
Example 6-1	Performance Trade-offs	6-4

LIST OF TABLES

Table 1-1	History of Standards and Manuals	1-7
Table 3-1	Standard Air Film R-values	3-8
Table 3-2	Wood Framed Assembly U-values (excerpt from Table B-2, Appendix B)	3-8
Table 3-3	Wood Framing Percentage	3-9
Table 3-4	Metal Framed Assembly U-values (excerpt from Table B-2)	3-9
Table 3-5	Metal Framing Factors	3-10
Table 3-6	Properties of Hollow Unit Masonry Walls (excerpt from Table B-4)	3-10
Table 3-7	Properties of Solid Unit Masonry and Solid Concrete Walls (excerpt from Table B-5)	3-11
Table 3-8	Effective R-Values for Interior Insulation Layers on Structural Mass Walls (excerpt from Table B-6)	3-11
Table 3-9	Thermal Mass Properties	3-11
Table 3-10	Default Fenestration Product U-Values	3-12
Table 3-11	Default Solar Heat Gain Coefficient	3-13
Table 3-12	Overhang Factors	3-14
Table 3-13	Maximum Air Infiltration Rates	3-15
Table 3-14	Certified Insulating Materials	3-16
Table 3-15	Roof/Ceiling Requirements	3-18
Table 3-16	Wall Requirements	3-19
Table 3-17	Floor/Soffit Requirements	3-20
Table 3-18	Window Requirements	3-20
Table 3-19	Skylight Requirements	3-21
Table 3-20	Nonresidential Requirements	3-23
Table 3-21	High-Rise Residential and Hotel/Motel Guest Room Requirements	3-23
Table 3-22	Temperature and Solar Factors	3-27
Table 3-23	Glazing Orientation Weighting Factors	3-28
Table 4-1a	Minimum Ventilation Rates	4-12
Table 4-1b	UBC Occupant Densities (sf/person)	4-13
Table 4-2	Required Minimum Ventilation Rate Per Occupancy	4-14
Table 4-3	Pipe Insulation Thickness	4-27
Table 4-4	Duct Insulation Requirements	4-29

Table 5-1	Effective Aperture Matrix	5-13
Table 5-2	Typical Efficacy of Luminaires	5-21
Table 5-3	Complete Building Method Lighting Power Density Values	5-24
Table 5-4	Area Category Method LPD Values	5-26
Table 5-5	Illuminance Categories for Tasks	5-29
Table 5-6	Typical RCRs for Flush/Recessed Luminaires (Task height 2.5 ft above floor)	5-31
Table 5-7	Illuminance Categories A-E	5-32
Table 5-8	Illuminance Categories F-I	5-32
Table 5-9	Mounting Height Adjustments	5-33
Table 5-10	Power Savings Adjustments for Lighting Controls	5-44

LIST OF EQUATIONS

Equation 3-1	Relative Solar Heat Gain	3-14
Equation 3-2	Standard Building Heat Loss	3-24
Equation 3-3	Proposed Building Heat Loss	3-26
Equation 3-4	Standard Building Heat Gain	3-26
Equation 3-5	Proposed Building Heat Gain	3-28
Equation 3-6	Energy Use Goal	3-30
Equation 4-1	Insulation Thickness	4-27